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TECHNICAL REPORT

75-64-FEL

# EFFECT OF STORAGE CONDITIONS ON THE QUALITY OF COMPRESSED FOOD BARS

By

Abdul R. Rahman,
Harold Gorfien,
Donald E. Westcott,
Glenn Schafer,
David DuBose

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UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760


Food Engineering Laboratory

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| QUALITY | CONCENTRATED FOODS | RATIONS | TEXTURE |
| COMPRESSED FOODS | PACKAGING MATERIALS | FOOD PACKETS | FLAVOR |
| COMPRESSION | MATERIALS | CONTAINERS | TESTS |
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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Four prototype compressed bars - cherry, beef noodle soup, corn flake and bean salad - were developed in the laboratory. They were then produced by commercial firms and were evaluated in prototype individual ration packets in the field. Storage studies indicate that the average technological ratings for color, flavor and texture of dry as well as rehydrated bars were not adversely affected after storage for 3, 6 and 12 months at 4, 21 or 38°C or for 18 months at 4 or 21°C. The ratings of beef noodle soup were somewhat lower than the rest of the bars throughout the storage tests.

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## FOREWORD

Reducing the volume of foods saves military cargo and storage space, lessens the requirements for packaging materials, and hence decreases waste. Recently a new approach to this problem of reducing volume was undertaken; namely, examining the possibility of developing techniques for compressing certain formulated foods and subsequently restoring them to their original state by rehydration. Such compressed foods offer higher caloric value per unit volume than the uncompressed product and can be consumed without any further preparation, which is the utmost in convenience, or rehydrated to familiar type foods. In addition, they provide definite logistic advantages not only in operational rations, especially where resupply is not possible but also where space is critical, such as in submarines and space capsules.

This work was perfromed under project 1T762724AH99, Military Food Service and Subsistence Technology.

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# INTRODUCTION

Compressed foods which can be eaten "out-of-hand" or rehydrated to a familiar product are of significant importance in feeding the military man in non-resupply operational situations. The need for such acceptable and stable foods has been expressed by the Armed Services. Land Warfare Laboratory order #71-09 asked for the exploratory development and production of prototype bars for a potential seven-day strategic operations patrol ration packet.

This paper describes the development of four such prototype bars; noodle, corn flake, cherry and bean salad bars.

Nonreversibly compressed foods which can be eaten without rehydration, such as cereal bars and beef jerky bars, previously have been successfully developed (Helmer and Tuomy, 1969). Various single foods in the fruit, vegetable & meat category have been "reversibly" compressed and subsequently restored to their normal appearance and texture through rehydration. However, research on the variables affecting the compression of formulated foods has not been extensive.

Fitzmaurice, et al. (1969) indicated that compressed bars produced from freeze-dried meat balls and pork sausage links show promise for use in operational rations. Compression ratios of 3.7:1 for meat balls and 4.5:1 for pork sausage links were obtained. Reduction in volume of up to 8-fold was obtained by compressing dehydrated vegetables (Gooding and Rolfe, 1957). Hamdy (1962) stated that the achievement of acceptable products from the compressed form varies considerably. Ishler (1962) in his patented process reported that spraying the rehydrated food with water, glycerine or propylene glycol before compression produced bars with excellent rehydration characteristics. Brockmann (1966) reported that freeze-dried foods properly preconditioned can be compressed with little or no fragmentation and that most foods so compressed can be restored to their precompression characteristics. Rahman, et al. (1969) reported that freeze-dried peas, corn, sliced onions, spinach, carrots, and green beans were successfully compressed, and compression ratios of 4:1, 4:1, 5:1, 11:1, 14:1, and 16:1 were obtained respectively. Compressed discs approximately 3-3/4 inch diameter have been developed from freeze-dried blueberries and red tart pitted (RTP) cherries. They can be successfully rehydrated and used in the preparation of pies (Rahman, et al. 1969). However, the products mentioned above are designed to be rehydrated rather than to be eaten "out of hand". Tuomy (1971) indicated that six combination meat prototype reversibly compressed bars were developed which are considered candidates for use in individual ration packets which can be eaten "out of hand" or rehydrated to their familiar form.

## EXPERIMENTAL PROCEDURES

Four compressed food bars, namely, kidney bean salad bar, cherry bar, beef noodle soup bar and corn flake bar were commercially prepared in accordance with production guides in Appendix A, B, C and D, respectively. They were packaged in accordance with the packaging production guide in Appendix E. These guides were prepared as a result of research and development work performed at the US Army Natick Laboratories, Food Engineering Laboratory.

The compressed packaged food bars were delivered to the US Army Natick Laboratories and were immediately placed in storage at $4^{\circ}$, $21^{\circ}$ and $38^{\circ}C$. Bars stored at $4^{\circ}$ or $21^{\circ}C$ were evaluated by a technological panel consisting of ten (10) experienced judges for color, odor, flavor, texture and appearance using a nine (9) point scale (9-Excellent to 1-Extremely Poor) at 3, 6, 12 and 18 month intervals. Bars stored at $38^{\circ}C$ were similarly tested at 3, 6 and 12 month intervals.

The bars were evaluated in the dry form as well as in the rehydrated form. Rehydration was performed in accordance with the production guides using cold water. Data obtained was statistically evaluated by analysis of variance.

## RESULTS AND DISCUSSION

Corn Flake Bars: Average technological panel ratings of flavor of dry as well as rehydrated corn flake bars, as shown in Table 1, indicate that storage time and temperature did not have significant effect. Flavor ratings of both rehydrated and dry bars after 12 months storage at 4°, 21° and 37°C or 18 months at 4° and 21°C were not significantly different from those of the initial samples. Results also indicate no significant difference between dry and rehydrated samples regardless of the time and temperature of storage. Average technological ratings of color and texture, as shown in Tables 2 and 3, indicate similar results as that obtained for the flavor.

Beef Noodle Soup Bars: Results shown in Tables 4 and 5 indicate that the average technological ratings for flavor and texture were rather low throughout these studies; therefore, storage studies were limited to 12 months only. The flavor and texture of rehydrated bars after storage for 3 and 6 months at 21° or 38°C were significantly lower than the initial samples (Tables 4 and 5), whereas the color was not affected by storage time and temperature, as shown in Table 6. In general, the quality of this food bar needs to be improved.

Cherry Bar: Results shown in Tables 7, 8 and 9 indicate that the color, flavor and texture were not affected by storage time and temperature. Average technological panel ratings of color, flavor or texture after 3, 6 and 12 months at 4°, 21° and 38°C or 18 months at 4° and 21°C were not significantly different from the initial samples. No significant differences between dry or rehydrated samples were shown throughout the storage studies.

Bean Salad Bars: Results shown in Tables 10 and 11 indicate that the color & flavor of dry or rehydrated bean salad bars were not affected by storage time and temperature. Average technological ratings of color and flavor of these bars after 12 months storage at 4°, 21° or 38°C or 18 months at 4° or 21°C were not significantly different from the initial dry or rehydrated samples. No significant difference was shown in the color & flavor of dry or rehydrated samples throughout the storage tests. However, the texture of rehydrated samples after storage for 3 or 6 months at 21°C were significantly lower than the initial samples or samples stored for 12 or 18 months (Table 12). This seems to be unusual and may be due to faulty packaging or incorrect rehydration procedures. Otherwise the texture results were similar to that obtained for the flavor & color.

## Conclusion

Compressed food bars which can be eaten as is or rehydrated to a familiar food and which offer acceptability and stability can be commercially produced for use in individual ration packets. However, further work is recommended to develop objective measurements so that assurance for reproducibility of high quality product can be attained.

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Table 1 - Average Technological Ratings of Flavor of Compressed Corn Flake Bars as Affected by Storage Conditions

| Time (Months) | Temperature 4°C Dry | 4°C Rehyd. | 21°C Dry | 21°C Rehyd. | 38°C Dry | 38°C Rehyd. |
|---|---|---|---|---|---|---|
| 0 | 6.4 | 6.6 | 6.4 | 6.6 | 6.4 | 6.6 |
| 3 | 5.8 | 6.6 | 6.1 | 6.2 | 5.9 | 6.2 |
| 6 | 6.2 | 5.9 | 5.8 | 5.7 | 5.8 | 5.6 |
| 12 | 6.3 | 5.9 | 6.1 | 6.7 | 5.5 | 5.6 |
| 18 | 6.4 | 6.4 | 6.1 | 6.0 | --- | --- |

No significant difference at the 5 percent level

Table 2 - Average Technological Ratings of Color of Compressed Corn Flake Bars as Affected by Storage Conditions

| Time (Months) | Temperature 4°C Dry | 4°C Rehyd. | 21°C Dry | 21°C Rehyd. | 38°C Dry | 38°C Rehyd. |
|---|---|---|---|---|---|---|
| 0 | 6.3 | 6.7 | 6.3 | 6.7 | 6.3 | 6.7 |
| 3 | 6.8 | 6.8 | 6.4 | 6.4 | 6.5 | 6.6 |
| 6 | 6.6 | 6.1 | 6.5 | 6.4 | 6.4 | 5.9 |
| 12 | 6.2 | 6.2 | 6.4 | 6.6 | 5.8 | 6.4 |
| 18 | 6.7 | 6.8 | 6.7 | 6.2 | --- | --- |

No significant difference at the 5 percent level

Table 3 - Average Technological Ratings of Texture of Compressed Corn Flake Bars as Affected by Storage Conditions

| Time (Months) | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 4°C | | 21°C | | 38°C | |
| | Dry | Rehyd. | Dry | Rehyd. | Dry | Rehyd. |
| 0 | 5.9 | 5.2 | 5.9 | 5.2 | 5.9 | 5.2 |
| 3 | 5.9 | 6.1 | 6.0 | 5.1 | 6.2 | 5.7 |
| 6 | 5.6 | 6.0 | 6.1 | 5.2 | 5.8 | 4.9 |
| 12 | 6.1 | 5.9 | 6.0 | 5.7 | 5.7 | 5.3 |
| 18 | 6.2 | 5.7 | 6.5 | 5.4 | --- | --- |

No significant different at the 5 percent level

Table 4 - Average Technological Ratings of Flavor of Compressed Beef Noodle Soup Bars as Affected by Storage Conditions

| Time (Months) | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 4°C | | 21°C | | 38°C | |
| | Dry | Rehyd. | Dry | Rehyd. | Dry | Rehyd. |
| 0 | 5.4 | 5.5 | 5.4 | 5.5 | 5.4 | 5.5 |
| 3 | 5.8 | 5.3 | 4.9 | 4.6 | 3.9* | 4.5 |
| 6 | 4.0* | 3.6* | 4.4 | 3.7* | 4.5 | 3.6* |
| 12 | 5.4 | 5.1 | 5.4 | 4.5 | 4.6 | 4.4 |

*Significant difference at the 5 percent level

Table 5 - Average Technological Ratings of Texture of Compressed Beef Noodle Bars as Affected by Storage Conditions

| Time (Months) | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 4°C | | 21°C | | 38°C | |
| | Dry | Rehyd. | Dry | Rehyd. | Dry | Rehyd. |
| 0 | 5.2 | 4.8 | 5.2 | 4.8 | 5.2 | 4.8 |
| 3 | 5.3 | 5.1 | 5.3 | 4.3 | 5.3 | 5.3 |
| 6 | 4.0 | 3.5* | 5.7 | 3.7* | 5.2 | 3.6* |
| 12 | 5.9 | 5.1 | 5.0 | 4.7 | 4.9 | 4.4 |

* Significant difference at the 5 percent level

Table 6 - Average Technological Ratings of Color of Compressed Beef Noodle Soup Bars as Affected by Storage Conditions

| Time (Months) | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 4°C | | 21°C | | 38°C | |
| | Dry | Rehyd. | Dry | Rehyd. | Dry | Rehyd. |
| 0 | 5.6 | 5.5 | 5.6 | 5.5 | 5.6 | 5.5 |
| 3 | 6.6 | 6.3 | 5.4 | 5.3 | 5.6 | 6.1 |
| 6 | 5.3 | 4.9 | 5.2 | 5.1 | 5.9 | 4.8 |
| 12 | 5.9 | 5.8 | 5.5 | 5.9 | 5.1 | 6.3 |

No significant difference at the 5 percent level

Table 7 - Average Technological Ratings of Color of Compressed Cherry Bars as Affected by Storage Conditions

| Time (Months) | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 4°C | | 21°C | | 38°C | |
| | Dry | Rehyd. | Dry | Rehyd. | Dry | Rehyd. |
| 0 | 6.1 | 6.2 | 6.1 | 6.2 | 6.1 | 6.2 |
| 3 | 5.4 | 5.7 | 6.2 | 6.1 | 6.4 | 6.5 |
| 6 | 6.3 | 5.9 | 6.4 | 6.1 | 6.6 | 5.8 |
| 12 | 6.3 | 6.4 | 6.4 | 6.9 | 6.2 | 6.3 |
| 18 | 6.7 | 7.1 | 6.8 | 6.8 | --- | --- |

No significant difference at the 5 percent level

Table 8 - Average Technological Ratings of Flavor of Compressed Cherry Bars as Affected by Storage Conditions

| Time (Months) | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 4°C | | 21°C | | 38°C | |
| | Dry | Rehyd. | Dry | Rehyd. | Dry | Rehyd. |
| 0 | 6.0 | 5.5 | 6.0 | 5.5 | 6.0 | 5.5 |
| 3 | 4.9 | 5.2 | 5.7 | 5.2 | 5.8 | 5.3 |
| 6 | 5.9 | 5.0 | 5.3 | 4.9 | 5.3 | 5.2 |
| 12 | 5.5 | 5.1 | 5.7 | 6.2 | 6.5 | 5.8 |
| 18 | 6.4 | 6.4 | 6.2 | 5.8 | --- | --- |

No significant difference at the 5 percent level

Table 9 - Average Technological Ratings of Texture of Compressed Cherry Bars as Affected by Storage Conditions

| Time (Months) | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 4°C | | 21°C | | 38°C | |
| | Dry | Rehyd. | Dry | Rehyd. | Dry | Rehyd. |
| 0 | 5.9 | 5.0 | 5.9 | 5.0 | 5.9 | 5.0 |
| 3 | 5.4 | 5.0 | 5.9 | 4.9 | 5.9 | 5.3 |
| 6 | 5.5 | 4.7 | 5.8 | 4.7 | 5.9 | 4.8 |
| 12 | 5.8 | 5.1 | 6.1 | 6.0 | 6.8 | 5.8 |
| 18 | 6.4 | 6.2 | 6.6 | 5.6 | --- | --- |

No significant difference at the 5 percent level

Table 10 - Average Technological Ratings of Color of Compressed Bean Salad Bars as Affected by Storage Conditions

| Time (Months) | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 4°C | | 21°C | | 38°C | |
| | Dry | Rehyd. | Dry | Rehyd. | Dry | Rehyd. |
| 0 | 6.2 | 6.5 | 6.2 | 6.5 | 6.2 | 6.5 |
| 3 | 6.5 | 6.7 | 6.2 | 6.1 | 6.4 | 6.3 |
| 6 | 5.8 | 5.9 | 6.3 | 5.6 | 6.2 | 5.7 |
| 12 | 6.2 | 6.2 | 6.3 | 6.7 | 5.6 | 6.1 |
| 18 | 6.1 | 6.7 | 6.8 | 6.5 | --- | --- |

No significant difference at the 5 percent level

Table 11 - Average Technological Ratings of Flavor of Compressed Bean Salad Bars as Affected by Storage Conditions

| Time (Months) | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 4°C | | 21°C | | 38°C | |
| | Dry | Rehyd. | Dry | Rehyd. | Dry | Rehyd. |
| 0 | 6.2 | 6.5 | 6.2 | 6.5 | 6.2 | 6.5 |
| 3 | 6.5 | 6.9 | 6.0 | 5.9 | 6.4 | 6.3 |
| 6 | 5.3 | 5.8 | 5.5 | 5.2 | 6.0 | 5.7 |
| 12 | 5.7 | 5.9 | 6.2 | 6.7 | 5.1 | 6.0 |
| 18 | 5.8 | 6.4 | 6.7 | 6.5 | --- | --- |

No significant difference at the 5 percent level

Table 12 - Average Technological Ratings of Texture of Compressed Bean Salad Bars as Affected by Storage Conditions

| Time (Months) | Temperature | | | | | |
|---|---|---|---|---|---|---|
| | 4°C | | 21°C | | 38°C | |
| | Dry | Rehyd. | Dry | Rehyd. | Dry | Rehyd. |
| 0 | 5.6 | 5.8 | 5.6 | 5.8 | 5.6 | 5.8 |
| 3 | 6.1 | 6.6 | 5.8 | 4.3* | 5.8 | 6.2 |
| 6 | 5.5 | 4.9 | 5.9 | 4.2* | 5.7 | 5.2 |
| 12 | 5.1 | 5.9 | 6.2 | 6.0 | 5.2 | 6.1 |
| 18 | 5.8 | 6.1 | 6.3 | 5.9 | --- | --- |

* Significant difference at the 5 percent level

APPENDIX A

Production Guide
Compressed Food Bar Prototype
US Army Natick Laboratories
June 1971

KIDNEY BEAN SALAD BAR

1. This product is a compressed salad bar containing dark red kidney beans, celery, eggs, vinegar, sweet relish, salad dressing, green bell peppers, onion, salt, and black pepper.

2. All material shall be in excellent condition, clean, sound, wholesome and free from evidence of insect infestation, foreign and undesireable odors, flavors, colors and extraneous materials.

2.1 Kidney Beans, Dark Red, Canned in Sauce. The beans shall be washed free of sauce, drained, and slit in a slitting machine with an opening of 3/16" (pea size).

2.2 Celery. Fresh celery shall be chopped or diced to a dimension range of $\frac{1}{2}$" x $\frac{1}{4}$" to 3/16" x 2/16".

2.3 Eggs. Fresh eggs shall be placed in water, brought to boiling, and allowed to remain for 10 minutes in the hot (not boiling) water. The eggs shall be cooled immediately, peeled, and chopped to a dimension range of $\frac{1}{2}$" x $\frac{1}{4}$" to 1/8" x 1/8".

2.4 Vinegar. White vinegar of 5 percent acidity shall be used.

2.5 Sweet Relish. Good quality sweet relish shall be used.

2.6 Salad Dressing. Miracle Whip salad dressing was used in the developmental work. Salad dressing of equivalent quality shall be used.

2.7 Green Bell Peppers. Fresh green bell peppers shall be cored and chopped to a dimension range of $\frac{1}{4}$" x $\frac{1}{4}$" to 1/8" x 1/8".

2.8 Onion. Fresh onions shall be washed after skin and outer layer are discarded. They shall be chopped to a dimension range of 3/16" x 3/16" to 1/16" x 1/16".

2.9 Salt. Salt shall be non-iodized.

2.10 Black Pepper. Pure ground black pepper shall be used in foods.

3. Formula.

| | Percent By Weight |
|---|---|
| Kidney Beans | 61.6 |
| Celery | 8.1 |
| Eggs | 7.3 |
| Vinegar | 7.1 |
| Relish, sweet | 5.5 |
| Salad Dressing | 5.4 |
| Green Bell Peppers | 2.7 |
| Onion | 2.0 |
| Salt | 0.26 |
| Pepper, black | 0.04 |

4. Preparation.

4.1 Washing. All vegetables shall be thoroughly washed in cold water prior to processing.

4.2 Mixing. All ingredients shall be combined, beans and eggs last. Gently fold in beans and eggs so as not to fracture. Spread on trays and freeze at a temperature not more than -10°F. Freeze-dry at a temperature not higher than 120°F. and at a maximum pressure of 1.5 mm. A fine cold water spray shall be applied to the dry product until a level of 10 percent increase in weight of the dry product is reached. Several mixings shall be included to expose dry surfaces and assure uniform application of water. The product shall be placed in covered containers and allowed to equilibrate overnight.

4.3 Bar Formation. Thirty (30) grams of conditioned salad shall be compressed in a 3" x 1" mold at a pressure of 1200 ± 100 p.s.i. with a 5 second dwell period. The bar shall be redried in a vacuum at 120°F. and packaged. The bar shall be sufficiently strong to be handled during processing and packaging without breaking apart.

5. Finished Product.

5.1 Physical Requirements. The finished product shall comply with the following physical requirements:

a. There shall be no foreign material.

b. When 30 grams of product is rehydrated with 40 cc of cool water (70°F.) for 10 minutes, the product shall be rehydrated completely.

c. When rehydrated, the product shall have a pleasing flavor and odor. There shall be no off flavors or odors.

5.2 Moisture Requirements. The finished product shall contain not more than 2.5% of moisture when tested as follows:

Weigh 10 grams of the ground material into a dry aluminum weighing dish (approximately 3 3/4 inches in diameter and 3/4 inch in depth). Place the dish in a rapid moisture tester for 20 minutes at 130°C. After 20 minutes read percent moisture directly from rapid moisture tester.

APPENDIX B

Production Guide
Compressed Food Bar Prototype
US Army Natick Laboratories
June 1971

CHERRY BAR

1. This product is a compressed fruit bar containing dehydrated applesauce, sugar, freeze-dried lemon flavored potatoes, textured sour cherry flavored soy flour, slivered blanched almonds, freeze-dried cherry powder, dehydrated maraschino cherries and silica gel.

2. Material. All material shall be in excellent condition, clean, sound, wholesome and free from evidence of insect infestation, foreign and undesirable odors, flavors, colors and extraneous materials.

2.1 Apple Powder. Apple powder shall be prepared as follows:

McIntosh or Cortland variety apples shall be peeled and cored; then they shall be diced or sliced and blanched for 2 to 5 minutes in boiling water. Blanch time should be based on piece size. After blanching, the apples shall be cooled with tap water and drained. Next the blanched apples shall receive a one-minute dip in sodium bisulfite solution containing 1500 ± 200 ppm available $SO_2$. After dipping, the fruit shall be drained. Next the apple pieces shall be pressed to extract 45-55 percent of the juice by weight. The pressed apples shall be frozen; then freeze-dried at a pressure not to exceed 1.0 millimeter and a surface temperature not to exceed 120°F. The freeze-dried product shall be mechanically ground to a particle size that will rehydrate readily.

2.2 Sugar. Refined granulated sugar shall be used.

2.3 Freeze-dried Lemon Flavored Potatoes. Fresh potatoes (in season) shall be peeled, diced to a dimension of 3/8" x 3/8" x 1/4" and blanched in water in which lemon crystals are dissolved at the rate of 5.95 oz. avd. per gallon of water. Prior to blanching, the potatoes shall be kept submerged in water containing sodium meta-bisulfite at the rate of 1 gram per gallon of water. The blanching water shall be brought to a boil and the lemon crystals dissolved. The diced potatoes shall be blanched for 2 minutes in water which is not returned to the boiling point (200° ± 5°F.). The potatoes shall be drained and potatoes and solution quickly cooled. The potatoes shall then be soaked for 2 hours in the cooled solution, drained, frozen and freeze-dried at 120°F. (Lemon crystals used in developmental work were manufactured by Plant Industries.) Comparable varieties of lemon crystals may be substituted for those used in the developmental work.

2.4 Textured Soy Flour, Sour Cherry Flavored. Blend sour cherry flavor and vegetable oil in a 1 to 1 ratio. Blend 4 parts textured soy flour and 1 part cherry-oil. Shake the cherry flavor-oil blend before use. (In the developmental work, Food Material Corp. Sour Cherry Flavor #8139, Durkex 500 oil, Glidden-Durkee, and Texgran #10900, manufactured by Swift Chemical Co., were used. Equivalent products may be used.)

2.5 Almonds, Slivered. Almonds shall be fresh, blanched, and slivered.

2.6 Cherry Powder, Freeze-dried. Freeze-dried, R.T.P. cherries shall be powdered without introducing heat, and kept from caking by canning with desiccant bags.

2.7 Maraschino Cherries, Dehydrated. Maraschino cherries shall be washed, drained, chopped to a dimension range of 1/2" x 1/2" to 3/16" x 3/16", and air dried at 125°F. (60-70 minutes) to a moisture content of 10.25 ± 0.25%.

2.8 Silica Gel. Syloid 244 was used in the developmental stage. Comparable varieties may be used.

3. Formula.

| | Percent By Weight |
|---|---|
| Apple Powder, with sucrose and malic acid | 25.8 |
| Sugar | 22.7 |
| Potatoes, lemon flavored, freeze-dried | 15.6 |
| Textured Soy Protein, sour cherry flavored | 15.1 |
| Almonds, slivered | 10.9 |
| Cherry Powder, freeze-dried | 4.5 |
| Cherries, Maraschino, dehydrated | 3.9 |
| Silica Gel | 1.5 |

4. Preparation.

4.1 Mixing. The apple powder shall be blended with sugar and malic acid in the following proportion:

| | |
|---|---|
| Apple Powder | 100 parts |
| Sugar | 150 parts |
| Malic Acid | 1.5 parts |

The potatoes shall be sprayed with cold water to a level 12% greater than the freeze-dried potato weight; allowed to equilibrate in covered containers (overnight) and blended into the formula. The silica gel shall be placed in the mixing bowl first and all other ingredients added except the potatoes. The mixture shall be blended and the potatoes added and blended. Blending shall be accomplished at slow speed. A Varistat may be required to obtain slow speed. The formula shall be placed in a tightly covered container until compressed.

4.2 Bar Formation. Thirty grams of formula shall be placed in a 3" x 1" mold and compressed at 950 p.s.i. with a 10 second dwell period. The bars shall be redried in a vacuum at 120°F. The bars shall be sufficiently strong to be handled during processing and packaging without breaking apart.

5. Finished Product.

5.1 Physical Requirements. The finished product shall comply with the following physical requirements:

a. There shall be no foreign material.

b. When 30 grams of product is rehydrated with 50 cc of cool water (70°F.) for 10 minutes, the product shall be completely rehydrated.

c. When rehydrated, the product shall have a pleasing odor and flavor. There shall be no off flavors or odors.

5.2 Moisture Requirements. The finished product shall contain not more than 2.5% moisture when tested as follows:

Weigh 10 grams of the ground material into a dry aluminum weighing dish (approximately 3 3/4 inches in diameter and 3/4 inch in depth). Place the dish in a rapid moisture tester for 20 minutes at 130°C. After 20 minutes read percent moisture directly from rapid moisture tester.

APPENDIX C

Production Guide
Compressed Food Bar Prototype
US Army Natick Laboratories
June 1971

BEEF NOODLE SOUP BAR

1. This product is a beef noodle soup containing freeze-dehydrated beef, noodles and mushrooms. Brand names of ingredients or equipment were those used in development work and no indorsement of these items over other similar items is stated or implied.

2. Applicable documents.

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this production guide to the extent specified herein.

SPECIFICATIONS
FEDERAL
N-M-591 - Noodles
EE-S-631 - Spices, Ground and Whole
MILITARY
IP/DES S-18-0 Food Packet, Long Range Patrol

THE UNITED STATES PHARMACOPOEIAL CONVENTION, INC.
Pharmacopoeia of the United States.

3. Material. All material shall be in excellent condition, clean, sound, wholesome and free from evidence of insect infestation, foreign and undesirable odors, flavors, colors and extraneous materials.

3.1 Ground Beef Raw. As specified in paragraph 3.2.2 and 3.2.2.2 of IP/DES S-18-0 - Food Packet, Long Range Patrol.

3.1.1 Beef, Cooking. Beef shall be placed in stainless steel pans, covered, and cooked in steam under 5 pounds pressure. The center temperature of the ground beef shall be 165°F. or higher upon completion of the cooking. While still hot, the beef shall be drained of fat and other liquids using a stainless steel straining device with holes 1/8 inch in diameter. The beef shall be chilled and then chopped in such a manner that particle sizes will not exceed $\frac{1}{4}$ by $\frac{1}{4}$ by $\frac{1}{4}$ inch. Fat content of the cooked beef shall not exceed 15 percent. The beef particles shall then be spread on dehydrator trays and frozen.

3.2 Noodles. Enriched egg noodles ("fine" as specified in N-N-591 Noodles) shall be cooked in an excess of water until tender (at least 30 minutes simmering boil). The cooked noodles shall be drained and rinsed at least three times with cold water. The noodles shall then be spread on dehydrator trays and frozen.

3.2.1 Mushrooms. Mushrooms shall be sliced into bits and pieces no larger than 1/2 by 1/2 by 1/8 inch. Commercial methods used for cooking and preparing mushrooms for freeze dehydration shall be used. The mushrooms shall then be spread on dehydrator trays and frozen.

3.2.2 Pepper, white, ground. High quality ground white pepper shall be used.

3.2.3 Celery Seed. High quality celery seed shall be used.

3.2.4 Parsley Flakes. High quality parsley flakes shall be used.

3.2.5 Monosodium glutamate. Shall be of edible grade monosodium glutamate.

3.2.6 Caramel Color #800. (Miles Lab., or Sethness).

3.2.7 Maltrin-10. A hydrolyzed cereal solid of high viscosity, low hygroscopicity and low dextrose equivalent. This product shall be readily soluble in both cold and hot water, have no sweetness and be resistant to caking. It shall have a dextrose equivalent of 9-12, a maximum moisture content of 5.0% and a pH equal to approximately 4.0. It shall have a carbohydrate profile (approximate) of dextrose - 0.5%, disaccharide - 3.5%, trisaccharide - 6.5%, tetrasaccharide - 5.5%, pentasaccharide - 4.5%, and hexasaccharide and above - 79.50%.

3.2.8 Ribotide. A mixture of disodium 5-inosinate and disodium 5-guanylate.

3.2.9 Hydrolyzed Protein (Maggi Super BE). A hydrolyzed plant protein with partially hydrogenated vegetable oil added. Typical analysis is as follows: total solids - 96.0%, ash - 34.5%, organic solids - 61.5%, chloride calculated as sodium chloride 27.6%, total nitrogen - 7.73%, protein (Nx6.25) - 48.3%, monosodium glutamate - 25.6%, ammonium chloride - 3.74%, pH - 5.3, hydrogenated vegetable oil 1.5%.

3.2.10 Glycerin, USP. Glycerin shall meet the requirements of the Pharmacopoeia of the United States.

3.2.10.1 Glycerin Solution. A glycerin solution shall be prepared by mixing 5 parts of water by volume with 95 parts of glycerin by volume.

3.3 Dehydration. The beef, noodles, and mushrooms shall be freeze dehydrated by the method described in paragraph 3.4 of IP/DES S-18-0 "Food Packet, Long Range Patrol", except that the temperature of each product shall not exceed 130°F.

3.4 Time and Temperature Limitations. The materials and products shall be so handled as to comply with the limitations defined in paragraph 3.5 of IP/DES S-18-0 "Food Packet, Long Range Patrol".

3.5 Particle Size Reduction. After freeze dehydration, the noodles shall be reduced in size to individual pieces between 1/4 inch and 1 inch in length. After dehydration, the portion of the beef to be used as powdered beef shall be reduced in size to a powder with individual particles no larger than 1/16 inch in diameter.

4. Preparation.

4.1 Beef Noodle Soup. Beef noodle soup shall be prepared in accordance with the following formula:

| | Percent by weight |
|---|---|
| Beef, freeze dried, ground, cooked | 31.40 |
| Noodles, freeze dried | 9.10 |
| Mushrooms, freeze dried | 9.40 |
| Hydrolyzed Protein | 4.74 |
| White pepper | 0.08 |
| Celery seed | 0.14 |
| Parsley flakes | 0.14 |
| Caramel color | 0.31 |
| Ribotide | 0.15 |
| Monosodium glutamate | 0.61 |
| Maltrin-10 | 25.10 |
| Beef, freeze dried, powdered ground, cooked | 9.40 |
| Glycerin solution (5 parts water and 95 parts glycerin by volume) | 9.43 |
| | 100.00 |

A matrix shall be prepared from Maltrin-10, freeze dried powdered ground cooked beef, and the glycerin solution. The matrix shall be prepared in the following manner:

Freeze dried powdered ground cooked beef shall be preblended uniformly with maltrin-10. The glycerin solution shall be heated to 70°C. and then sprayed in a fine mist on to the preblended powdered beef and maltrin, while blending in an exclosed mixer. Temperature of the glycerin solution shall not fall below 54°C. during the spraying operation. Mixing shall continue for at least 5 minutes after spraying has terminated. The sides of the mixer shall be scraped free of any coating matrix and the coating matrix shall be incorporated into the rest of the matrix in the mixer by blending for at least an additional 5 minutes. The remaining ingredients shall be preblended uniformly. The matrix will then be added to the other preblended ingredients in a mixing device, and blended in such a manner as to result in a uniform mixture without appreciably reducing the size of the freeze dried noodles or freeze dried mushrooms.

4.2 Twenty one grams of the product shall be compressed in a 3" x 1" mold with minimal pressure (equivalent to 100 to 150 lbs. as indicated by gauge on Carver Press) and a 15 second dwell time. The bars shall then be packaged. The bars shall be sufficiently strong to be handled during processing and packaging without breaking apart.

5. Finished Product.

5.1 Physical Requirements. The finished product shall comply with the following physical requirements:

(a) There shall be no foreign material such as, but not limited to, dirt, glass or paint.

(b) There shall be no evidence of incomplete dehydration such as damp or soggy areas.

(c) There shall be no evidence of thawing in the dehydrator.

(d) When 21 grams of product is rehydrated with 120 grams of either cool water (80°F.) or hot water (180°F.) for 10 minutes and stirred with a spoon, the product shall be rehydrated completely.

(e) When rehydrated as in (d) above, or consumed dry, the product shall have a pleasing flavor. There shall be no off flavor or odors.

(f) When rehydrated as in (d) above, the product shall show distinct noodles, mushrooms, and beef particles.

5.2 Moisture Requirement. The product shall contain not more than 3.3 percent moisture when tested as follows: Weigh 10 grams of the ground material into a dry aluminum weighing dish (approximately 3 3/4 inches in diameter and 3/4 inch in depth). Place the dish in a rapid moisture tester for 20 minutes at 130°C. After 20 minutes read percent moisture directly from rapid moisture tester.

APPENDIX D

Production Guide
Compressed Food Bar Prototype
US Army Natick Laboratories
June 1971

CORN FLAKE BAR

1. This product is a compressed cereal bar containing corn flakes, powdered milk, powdered sugar and low D.E. hydrolyzed cereal solids. Brand names of ingredients or equipment were those used in development work and no indorsement of these items over other similar items is stated or implied.

2. Material. All material shall be in excellent condition, clean, sound, wholesome and free from evidence of insect infestation, foreign and undesirable odors, flavors, colors and extraneous materials.

2.1 Corn Flakes. A variety of plain corn flakes shall be used which when hydrated to a moisture of 12.5% will be pliable and withstand compression without shattering.

2.2 Non-Fat Dry Milk. Non-fat dry milk shall be instantized.

2.3 Powdered Sugar. Powdered sugar shall be confectioners powdered sugar.

2.4 Maltrin 20. A variety of low D.E. hydrolyzed cereal solids shall be used which has a high solubility, forms clear, bland glazes and coatings which maintain their clarity on storage. It should also be slightly sweet. Maltrin-20 was used in development work.

3. Formula.

| | Percent by weight |
|---|---|
| Corn Flakes | 33.3 |
| Powdered Sugar | 25.0 |
| Maltrin 20 | 8.3 |
| Powdered Milk | 33.3 |

4. Preparation.

4.1 Mixing. All of the ingredients shall be mixed gently so that the corn flakes are not shattered. A moisture determination of this mixture shall then be made. It shall then be determined how much water must be added to bring the mixture to a 12.5% moisture level. This mixture shall then be placed on a flat surface which is supported by a weighing scale. A fine spray of water shall then be applied to achieve the proper increase in weight as determined by the required amount of added moisture. The spraying procedure shall include several periods of gentle mixing of the mixture. The mixture shall then be placed in a sealed container and the mixture allowed to equilibrate until

the product is pliable.

4.2 Bar Formation. Thirty grams of the cornflake mixture shall be used to make the bars. The mixture will be placed in a 3" x 1" mold and compressed at 200 + 25 psi. The bars shall be dried at 100°F. in a vacuum oven and packaged. The bars shall be sufficiently strong to be handled during processing and packaging without breaking apart.

5. Finished Product.

5.1 Physical Requirements. The finished product shall comply with the following physical requirements:

(a) There shall be no foreign material.

(b) When 30 grams of product is rehydrated with 30 cc of cool water (70°F.) for 10 minutes, the product shall be rehydrated completely.

(c) When rehydrated as in B above, the product shall have a pleasing flavor and odor. There shall be no off flavors or odors.

5.2 Analytical.

5.2.1 Moisture Requirement. The finished product shall contain not more than 2.5% moisture when tested as follows:

Weigh 10 grams of the ground material into a dry aluminum weighing dish (approximately 3 3/4 inches in diameter and 3/4 inch in depth). Place the dish in a rapid moisture tester for 20 minutes at 130°C. After 20 minutes read percent moisture directly from rapid moisture tester.

APPENDIX E

Packaging Production Guide
Compressed Food Bar Prototype
US Army Natick Laboratories
June 1971

1. Packaging. Components packaging shall be performed in accordance with 1.1. Materials used shall be those listed in 1.2.

1.1. The following sequence shall be followed in the packaging operation.

1.1.1 Labeling of the inner bag. The specific pressure sensitive directions label (1.2.c.) for the food bars being packaged shall be applied to the polyethylene bag (1.2.a) by placing the bottom edge of the label 1-3/4 inches ± 1/8 inch parallel to the bottom of the bag.

1.1.2. Filling. The food bar (as applicable) shall be packaged into the labeled polyethylene bag with the long dimension of the bar parallel to the opening of the bag. The bag shall be closed by folding the excess bag material neatly around the bar. The bag shall not be sealed. One paper clip (1.2.e.) shall be placed under the final fold of the polyethylene bag. The package shall then be placed into a plastic-foil laminated bag (1.2.b.) with the long dimension of the bar parallel to the long dimension of the bag.

1.1.2. Sealing. The filled laminated bag shall be closed by evacuating the air from within the packages to a vacuum level of not less than 28 inches (i.e. 2 inches of mercury pressure) as registered on a vacuum gauge on the closing machine. The evacuated air shall be replaced by flushing back pure nitrogen into the package to a level of 10 to 15 inches of mercury. The bag shall then be closed by heat sealing with a seal of not less than 1/4 inches (+16) wide. Prior to performing the closing operation the accuracy of the vacuum gauge on the closing machine shall be verified by means of a manometer or other suitable device. The verification check shall be performed each day prior to the start of the packaging operation and a record of this verification shall be maintained by the supplier. The sealed package shall be capable of passing the leakage test specified in paragraph 4.

1.2 Materials. The following materials used in the packaging and labeling operations shall be furnished by the US Army Natick Laboratories:

a. Polyethylene bag (inner), size 4 by 7 inches.
b. Plastic-foil laminated bag, size $2\frac{1}{2}$ by $5\frac{1}{2}$ inches (ID).
c. Pressure - sensitive instructions label.
d. Pressure - sensitive component label.
e. Paper clips.

Shipping containers shall be furnished by the contractor and shall be in accordance with the provisions of paragraph 2.

2. Packing. Two hundred and fifty bars (all of one component) shall be packed in layers in a fiberboard shipping container which is acceptable to the common carrier for safe transportation to the US Army Natick Laboratories at the lowest rate for such supplies.

3. Labeling and Marking.

3.1 Component Bag. Each component bag shall be labeled with the applicable pressure sensitive component label (5.1.2.d.).

3.2 Shipping Container. Each shipping container shall convey the identification of the specific food bar contained. These shall be as follows:

Kidney Bean Salad Bar
Corn Flake Bar
Cherry Dessert Bar
Beef Noodle Soup Bar

4. Leakage Examination on Component Package. The filled and sealed food bar component package shall be examined for leakage by submerging in water contained in a desiccator or other suitable container, and maintaining a vacuum of 10 inches of mercury (atmospheric pressure 29.9 inches) for at least 30 seconds. A steady progression of bubbles from any point of the package will indicate a leak. Isolated or static bubbles caused by entrapped air in seams or surfaces of the packages will not be considered as signs of leaks.

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